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(54) FILM RESISTOR TERMINATOR.

(57) A film resistor terminator used in microwave bands. The object is to provide a film resistor that exhibits sufficient terminal characteristics even in high frequency bands. For this prupose, a structure of the terminator is such that a film resistor (40) is additionally provided to cancel the inductive reactance component inherent in a film resistor (30) conventionally provided. Another structure is that the film resistor (30) is divided into a plurality of parts (31,32,33) so as to decrease the inductive reactances of the parts (31,32,33).

FILM RESISTANCE TERMINATOR

[FIELD OF THE INVENTION]

The present invention relates to a terminator utilizing a film resistance. In more detail, the present invention particularly relates to a structure of resistive terminator which is to be used in the microwave frequency band and is constituted through use of microstrip line and film resistance.

[BACKGROUND ART]

A film resistance terminator is used for terminating the line by absorbing an energy propagated on the transmission line without reflection. In this case, absorbed energy is converted to heat. Namely, the film resistance terminator never reflects an input signal and is used, for example, to absorb the signal as a terminator of a hybrid circuit, etc.

A structure of an example of the conventional film resistance terminator is shown in Fig. 1 and Fig. 2. Fig. 1 is a plan view of a film resistance terminator, while Fig. 2 is a sectional view along the line Y-Y' in Fig. 1. In this figure, the numeral 10 designates a dielectric material substrate; 11, a conductor film; 12, a grounding conductor; 13, a first microstrip line; 14, a second microstrip line; 15, a conductor ribbon; 30, a film resistance consisting of a thin or thick film such as a tantalum nitride.

A structure of the film resistance will then be explained. A flat area is formed as a step-down area at a part of the grounding conductor 12. On this flat area, the dielectric material substrate 10 covered with the conductor film 11 at the rear surface thereof is mounted. Moreover, a first microstrip line 13 as a signal input part, a film resistor 30 which becomes a termination resistor connected to the first microstrip line 13 and a second microstrip line 14 for grounding the film resistor 30 are formed on the dielectric material substrate 10. In this case, the second microstrip line 14 is arranged at the end part of dielectric material substrate 10 and is almost flat for the upper step surface of the grounding conductor 12. Moreover, the conductor film 11 at the rear surface of the dielectric material substrate 10 is provided in close contact with the flat area of the grounding conductor 12. In addition, the conductor ribbon 15 is formed to electrically connect the second microstrip line 14 and the grounding conductor 12. Regarding the characteristic and size of each element, for example, the dielectric material substrate 10 is formed by alumina ceramics having the dielectric constant of 9.8 and thickness of 0.38 mm. The microstrip lines 13, 14 are formed by the conductor in the width of 0.36 mm and thickness of 0.003 mm, while the second microstrip line 14 has the length of 0.1 mm. The film resistor 30 has the width of 0.3 mm and length of 0.3 mm.

In this structure, for functioning as a terminator, the characteristic impedance of the first microstrip line is set equal to a DC resistance value of the film resistor for impedance matching. In this case, the characteristic impedance of first microstrip line is set to 50 ohms and therefore, a DC resistance of film resistor 30 is also set to 50 ohms which is equal to such characteristic impedance. With such structure, the input signal is terminated.

A return loss at the conventional film resistance terminator described above, namley a rate of appearance of reflected wave for the input signal is by the curve A in Fig. 3. This graph indicates a result of calculation for obtaining a return loss through the simulation by inputting sizes of respective parts of the film resistance terminator and then changing the frequency of input signal.

As will be understood from the graph of Fig. 3A, the structure of conventional film resistor provides a good return loss in the comparatively low frequency band but shows deterioration of return loss for higher frequency band.

Next, a cause of deterioration of return loss in such a higher frequency band will be discussed. A film resistor which is easily influenced by the frequency can be thought as a cause. Therefore, a method of obtaining an input impedance of transmission path which results in load termination as shown in Fig. 4 will be indicated in order to search the characteristics of film resistor.

When

α ; attenuation constant

β ; phase constant

Z_R; characteristic impedance (Ω),

an input impedance Z_{in} of the transmission line is indicated by the following formula.

$$Z_{in} = \frac{Z_R \cdot (K^2 - 1 + j\,2K\sin 2\beta l)}{(K^2 + 1 + j\,2K\sin 2\beta l)}$$

Here, $K = \exp(2\alpha 1)$ and the characteristic impedance Z_R is indicated by the following formula. $Z_R = [(R_0 + j\omega L_0)/(G_0 + j\omega C_0)]^{1/2}$

Where

R_0 ; resistance per unit length

G_0 ; conductance per unit length

L_0 ; inductance per unit length

C_0 ; capacitance per unit length

Here, if $G_0 >> \omega C_0$,

$Z_R = Z_0 (1 - j\, R_0 / \omega L_0)^{1/2}$

Where, $Z_0 = (L_0 / C_0)$, $^{1/2}$

It is the characteristic impedance of no-loss transmission path.

When $Z_R = R_R - jX_R$, the imput impedance Z_{in} becomes as follow.

$$Z_{in} = (R + jX) / (K^2 + 1 + 2K\cos 2\beta l) \quad \cdots (1)$$

Here,

$$R = R_R (K^2 - 1) + 2KX_R \sin 2\beta l \quad \cdots (2)$$

$$X = 2KR_R \sin 2\beta l - X_R (K^2 - 1) \quad \cdots (3)$$

An input impedance can be obtained as explained above.

Namely, when an input impedance of film resistor is obtained by the method explained above, the value of imaginary part of formula (1) becomes larger as the frequency increases in the range from 1 to 20 GHz under the same condition. Namely, an inductive reactance of the input impedance considering the film resistor becomes large. Moreover, the inductive reactance element of the microstrip line 14 also increases by the same cause. When the inductive reactance becomes large, the impedance characteristic in the side of film resistance viewed from the first microstrip line 13 is deteriorated.

As explained above, the conventional film resistance terminator has resulted in a problem that it shows deterioration of return loss when the frequency becomes high and does not provide sufficient termination characteristics.

[Disclosure of the Invention]

It is an object of the present invention to provide a film resistance terminator which ensures good return loss in wide frequency band with a simplified structure and in more detail to provide a film resistance terminator which ensures good return loss by bringing the reactance element of film resistor as a part of the film resistance terminator close to zero.

In order to attain such object, the present invention provides, as the first means, a film resistance terminator using a film resistor as shown in Fig. 6, comprising a first microstrip line 13 which is formed on the dielectric material substrate 10 to propagate an input signal, a first film resistor 30 which is connected with the end of microstrip line at the one end and is grounded at the other end to terminate the input signal, and a second film resistor which is connected in parallel with the first film resistor 30 and has a capacitive reactance element to cancel the inductive reactance element of the first film resistor 30.

Moreover, the present invention also provides, as the second means, a film resistance terminator comprising a first microstrip line 13 which is formed on the dielectric material substrate 10 to propagate an input signal and a first film resistor which is connected to the end of microstrip line at the one end and is grounded at the other end to terminate the input signal as shown in Fig. 8, wherein the first film resistor is formed by dividing the width of the first film resistor and connecting in parallel a plurality of film resistors 31, 32, 33.

[Brief Description of the drawings]

Fig. 1 indicates a conventional film resistance terminator;
Fig. 2 is a sectional view along the line Y-Y' in Fig. 1;
Fig. 3 shows return loss of various film resistance terminators;
Fig. 4 is a circuit of transmission line resulting in loss of load termination;
Fig. 5 shows input impedances when the length of various film resistors is changed;
Fig. 6 indicates a first embodiment of the present invention;
Fig. 7 is a sectional view along the line X-X' in Fig. 6;
Fig. 8 indicates a second embodiment of the present invention; and
Fig. 9 is a sectional view along the line B-B' in Fig. 8.

[Embodiment of the Invention]

The first embodiment of the present invention is shown in Fig. 6 and Fig. 7. Fig. 6 is a plan view of a film resistance terminator as an embodiment of the present invention and Fig. 7 is a sectional view along the line X-X' in Fig. 6. The like elements are designated by the like reference numerals throughout the drawings.

Moreover, Fig. 5 is given to explain input impedances of the film resistors. In this figure, the frequency is considered to 20 GHz which is largely influenced by the reactance element. In this embodiment, the inductive reactance element by the film reistor can be cancelled by providing a film resistor having the other capacitive reactance element. Therefore, a film resistance terminator is formed through the best combination which provides the desired value of combined resistance value and a combined reactance element close to zero by changing the length of the film resistors in various sizes and drawing a plurality of locie as shown in Fig. 5.

Like the prior art, the present invention provides a film resistor 40 having a capacitive reactance for cancelling inductive reactance of the film resistor 30 to a film resistance terminator formed by the dielectric material substrate 10 covered with a conductor film 11 at the rear surface, a grounding conductor 12, microstrip lines 13, 14, a film resistor 30 and a conductorribbon 15. Moreover, the microstrip line 24 for grounding the film resistor 40 and conductor ribbon 25 are further added.

Here, the dielectric material substrate 10 in this embodiment is formed by alumina ceramic with specific dielectric constant of 9.8 and thickness of 0.38 mm; the microstrip line 13 is formed by a conductor with width in the width of 0.36 mm and thickness of 0.003 mm. The microstrip line 14 for grounding the film resistor 30 has the width of 0.36 mm and length of 0.1 mm and this microstrip line 14 is grounded by the conductor ribbon 15. The film resistor 40 newly added has the width of 0.1 mm and length of 1 mm and the microstrip line 24 for grounding such film resistor has the width of 0.15 mm and length of 0.1 mm. The area resistivity of film resistor is 50 Ω/square.

For determination of above sizes, following graph is generated. For instance, a graph indicating the input impedances of the film resistors in the width of 0.3 mm, 0.15 mm and 0.1 mm calculated by inputting the practical values to the formula (1) is shown in Fig. 5. The horizontal axis of Fig. 5 denotes resistance element (herein after referred to as R_{in}), while the vertical axis, reactance element (hereinafter referred to as X_{in}). In the figure, a indicates an input impedance of the film resistor in the width of 0.3 mm, while b, that in the width of 0.15 mm and c, that in the width of 0.1 mm. This graph is obtained by plotting the impedances by changing the length of film resistor in the step of 0.1 mm under the frequency of 20 GHz.

In the case of graph a in Fig. 5, when the length is 0, both R_{in}, X_{in} are 0 Ω . When the length increases, both R_{in}, X_{in} also increase at the beginning. But, X_{in} is an inductive reactance element. When R_{in} becomes almost 50Ω, X_{in} reduces, on the contrary. When R_{in} becomes almost 90Ω, X_{in} changes to the capacitive reactance and increases. Moreover, R_{in} reduces, on the contrary, from about 115Ω, in addition, the capacitive reactance X_{in} also reduces from almost 70Ω, R_{in} is converted almost to 75Ω, while X_{in} is converged to almost 50Ω.

In the case of graph b in Fig. 5, when the length is zero, both R_{in} and X_{in} are 0Ω. When the length increases, both R_{in}, X_{in} increase at the beginning. However, X_{in} is inductive reactance element. When R_{in} bocomes about 70Ω, X_{in} reduces on the contrary. When R_{in} becomes almost 125Ω, X_{in} becomes capacitive reactance and increases. Meanwhile, R_{in} reduces, on the contrary, from about 160Ω and the capacitive reactance X_{in} also reduces from about 110Ω and R_{in} is converted to almost 120Ω, while X_{in} to almost 95Ω.

In the case of graph c in Fig. 5, when the length is zero, both R_{in}, X_{in} are 0Ω. When the length increases, both R_{in}, X_{in} increase at the beginning. However, X_{in} is inductive reactance element. When R_{in} becomes about 100Ω, X_{in} reduces on the contrary. When R_{in} becomes almost 140Ω, X_{in} becomes capacitive reactance and increases gradually. When R_{in} reaches about 220Ω, it gradually reduces on the contrary. In addition, the capacitive reactance X_{in} gradually reduces from about 150Ω and R_{in} is converged to almost 150Ω, while X_{in} to about 125Ω .

As will be understood from the above graph, the conventional film resistor 14 in this embodiment has the width of 0.3 mm and the length of 0.3 mm. Accordingly, it corresponds to the point al of the graph a, while R_{in} is 54Ω and inductive reactance element X_{in} is about 13Ω. Moreover, the film resistor 24 has the width of 0.1 mm and the length of 1 mm. Accordingly it corresponds to the point cl of the graph c, while R_{in} is 180Ω and capacitive reactance element X_{in} is about 148Ω. In this case, the combined R_{in}, X_{in} of a couple of film resistors can be expressed by the following formula when the characteristic impedance of film resistor 14 is $(R_1 + jX_1)$ and the characteristic impedance of film resistor 24 is $(R_2 + jX_2)$.

$$R_{in} + jX_{in} = \frac{(R_1 + jX_1)\ (R_2 + jX_2)}{(R_1 + jX_1) + (R_2 + jX_2)}$$

From calculation of above formula,
$R_{in} + jX_{in} = 48.56 + j4.7$

This is close to the desired resistance value, indicating that the reactance element becomes close to zero. Therefore, when the input signal is high frequency, a return loss can be improved. The return loss in the first embodiment of the above structure is a little deteriorated than the conventional one in the low frequency band as shown in Fig. 3B but is improved more than that of conventional one in the high frequency band. As a total, the return loss becomes 20 dB or more and total characteristic can be improved from the conventional one.

In addition, when the length of film resistor 14 is increased to 0.33 mm by about 0.03 mm, the resistance element becomes almost 50Ω. In this case, as shown in Fig. 3C, the return loss may be improved even for the low frequency input signal.

As explained above, a film resistance terminator providing good return loss can be obtained by drawing locie for the film resistors of various sizes as shwon in Fig. 5 and selecting the values resulting in the combined reactance element more closed to zero and the desired resistance value.

Next, a second embodiment of the present invention will be shown in Fig. 8 and Fig. 9. Fig. 8 is a plan view of a film resistance terminator as the embodiment, while Fig. 9 is a sectional view along the line B-B' in Fig. 8. Like the prior art, this embodiment comprises a dielectric material substrate 10 covered with a conductive film 11 at the rear surface thereof, a grounding conductor 12, microstrip lines 13, 14 and a conductor ribbon 15. Moreover, this embodiment has the divided three film resistors 31, 32, 33 in place of the conventional film resistor 30. The dielectric material substrate 10 is formed by alumina ceramic having a specific dielectric constant of 9.8 in the thickness of 0. 38 mm, the microstrip line 13 is formed by a conductor in the width of 0.36 mm and thickness of 0.003 mm, the microstrip line 14 connecting the film resistors 31, 32, 33 to the grounding conductor has the width of 0.36 mm and length of 0.1 mm and this microstrip line 14 is grounded by the conductor ribbon 15. The microstrip lines 31, 32, 33 have the width of 0.1 mm and length of 0.3 mm.

In general, a resistance value R of the film resistor is expressed as follows when the length of film resistor is l [mm], width is w [mm] and a resistivity is ρ [Ωmm].

$$\begin{aligned} R &= (\rho / t) \cdot (l / w) \\ &= R_s\ (l / w) \qquad [\Omega] \\ R_s &= (\rho / t) \end{aligned}$$

Here, R_s is an area resistivity and when the length and the width w of film resistor are constant, the resistance value R depends only on the thickness t.

Meanwhile, when the thickness t is set to a constant value, the area resistivity R_s also becomes constant and a resistance value R depends on the legnth and width w.

As shown in Fig. 8, the present embodiment obtains the desired resistance value as a combined resistance value by narrowing the width of one film resistor and increasing a resistance value of each film resistor by dividing a film resistor into a plurality of sections in the width direction and then connecting resistor sections in parallel.

Details are explained hereunder. As will be understood from the point c2 of graph c of Fig. 5, the characteristic impedance of the film resistors 31, 32, 33 can be judged as follows from the sizes thereof that R_{in} is about 150Ω and X_{in} is capacitive and several ohms. In this case, a total R_{in} of the film resistors divided into three sections can be calculated as 50Ω and it has the desired serial resistance value like the conventional one. On the contrary, the combined X_{in} becomes very small in comparison with the conventional one because each reactance element is several ohms. Accordingly, deterioration of characteristic impedance of the microstrip line 13 is also lowered even under the high frequency band. Therefore, a measured return loss of this embodiment can be considerably improved in comparison with the conventional one as shown in Fig. 3D.

Moreover, an application example of the second embodiment is shown in Fig. 10. In the terminator shown in Fig. 10, the microstrip line and conductor ribbon are also divided, in addition to the film resistor, corresponding thereto and thereby the microstrip lines 34, 35, 36 and conductor ribbons 26, 27, 28 are provided. In the second embodiment X_{in} of the microstrip line 14 and conductor ribbon 15 is not considered but the reactance element is decreased by dividing the microstrip line 14 and conductor ribbon 15 like the film resistor. Accordingly, as shown in Fig. 3E, the return loss is more improved than the second embodiment.

The present invention has been explained by referring to the embodiments thereof. However, the microstrip line and grounding conductor may be connected electrically with a gold line in place of the conductor ribbon. In addition, a number of divisions of film resistor is not limited only to three sections considering the sizes thereof and the film resistor may also be divided into two sections. In this case, the width of the one film resistor becomes 0.15 mm. As will be understood from the graph b of Fig. 5, the film resistor has the characteristics that R_{in} is about 100Ω and X_{in} is inductive resistance and becomes about 8Ω. Accordingly, the combined R_{in} of two film resistors is 50Ω having a serial resistance value similar to that of conventional film resistor, while the combined X_{in} becomes smaller than the conventional film resistor. However, in case the film resistor is divided into three sections, the reactance element becomes smaller and it is effective means. As explained above, the present invention is not limited only to such embodiments.

[Effect of the Invention]

As explained previously, the present invention is capable of reducing reactance element of film resistors through employment of the structure for cancelling the reactance element of the conventional film resistor and the structure for dividing the film resistor. Therefore, deterioration of impedance characteristic of microstrip line 14 under the high frequency band may be lowered. As a result, return loss can be improved and sufficient termination can be realized even under the high frequency band.

Claims

1. A film resistance terminator utilizing film resistors, comprising:
   a first microstrip line (13) formed on a dielectric material substrate (10) to propagate an input signal;
   a first film resistor (30) which is connected to the end part of said microstrip line at the one end thereof and is grounded at the other end thereof to terminate said input signal; and
   a second film resistor (40) connected electrically in parallel with said first film resistor (30) and having capacitive reactance to lower the inductive reactance of said first film resistor (30).

2. A film resistance terminator according to claim 1, wherein the length and width of said film resistor (40) are selected so that a combined DC resistance element of said first film resistor (30) and second film resistor (40) becomes almost equal to a resistance value of said first microstrip line (13).

3. A film resistance terminator according to claim 2, wherein said dielectric material substrate (10) forming the conductive film at the rear surface thereof is arranged on the grounding conductor (12), and the second microstrip lines (14, 24) connecting said first and second film resistors (30, 40) and the conductor ribbons (15, 25) for connecting said second microstrip lines (14, 24) to said ground conductor are also comprised.

4. A film resistance terminator according to claim 2, wherein the characteristic impedance of said first microstrip line (13) is 50Ω , the first film resistor (30) with the area resistivity of 50Ω/square formed by tantalum nitride has the width of 0.33 mm and length of 0.3 mm, while the second film resistor (40) has the width of 0.1 mm and length of 1 mm.

5. In a film resistance terminator comprising a first microstrip line (13) formed on a dielectric mateiral substrate (10) to propagate an input signal and a first film resistor which is connected to the end of said microstrip line at the one end thereof and is grounded at the other end thereof to terminate said input signal, said first film resistor is formed by dividing said first film resistor into a plurality of sections and connecting in parallel a plurality of film resistors (31, 32, 33).

6. A film resistance terminator according to claim 5, wherein said dielectric material substrate (10) forming conductor film at the rear surface thereof is arranged on the grounding conductor (12) and the second microstrip line (14) connected with said first film resistor (30) and the conductor ribbons (15, 25) for connecting said second microstrip line (14) to said grounding conductor are also comprised.

7. A film resistance terminator according to claim 6, wherein said second microstrip line and conductor ribbon are formed by a plurality of divided sections corresponding to said a plurality of film resistors and each film resistor is grounded.

8. A film resistance terminator according to claim 5, wherein the characteristic impedance of said microstrip line (13) is 50Ω, said first film resistor is divided into three sections, and three film resistors formed by tantalum nitride in the width of 0.1 mm and length of 0.3 mm are connected in parallel.

FIG.1

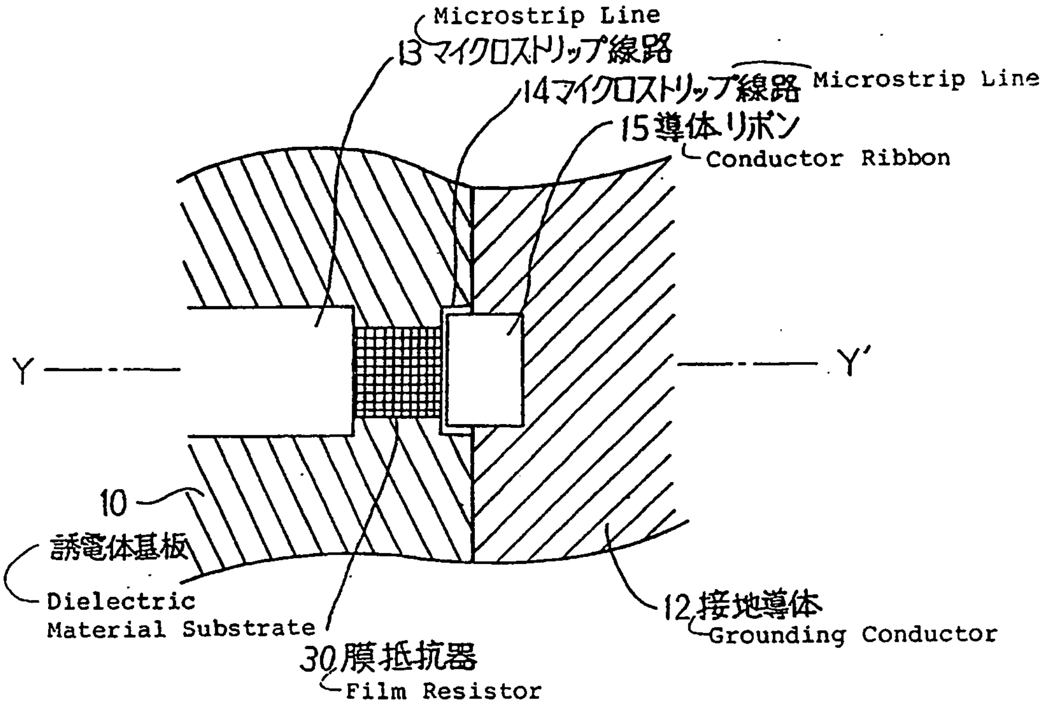

Microstrip Line
13 マイクロストリップ線路
14 マイクロストリップ線路
Microstrip Line
15 導体リボン
Conductor Ribbon
Y
Y'
10
誘電体基板
Dielectric
Material Substrate
30 膜抵抗器
Film Resistor
12 接地導体
Grounding Conductor

FIG.2

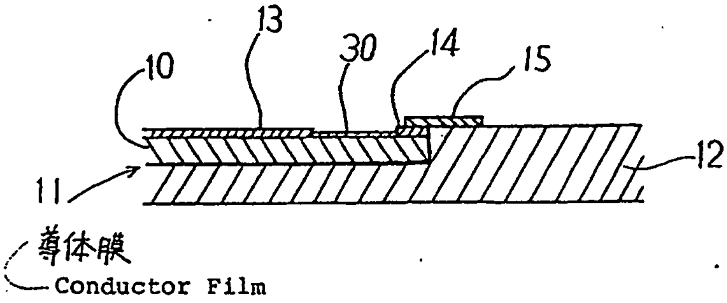

導体膜
Conductor Film

FIG. 3

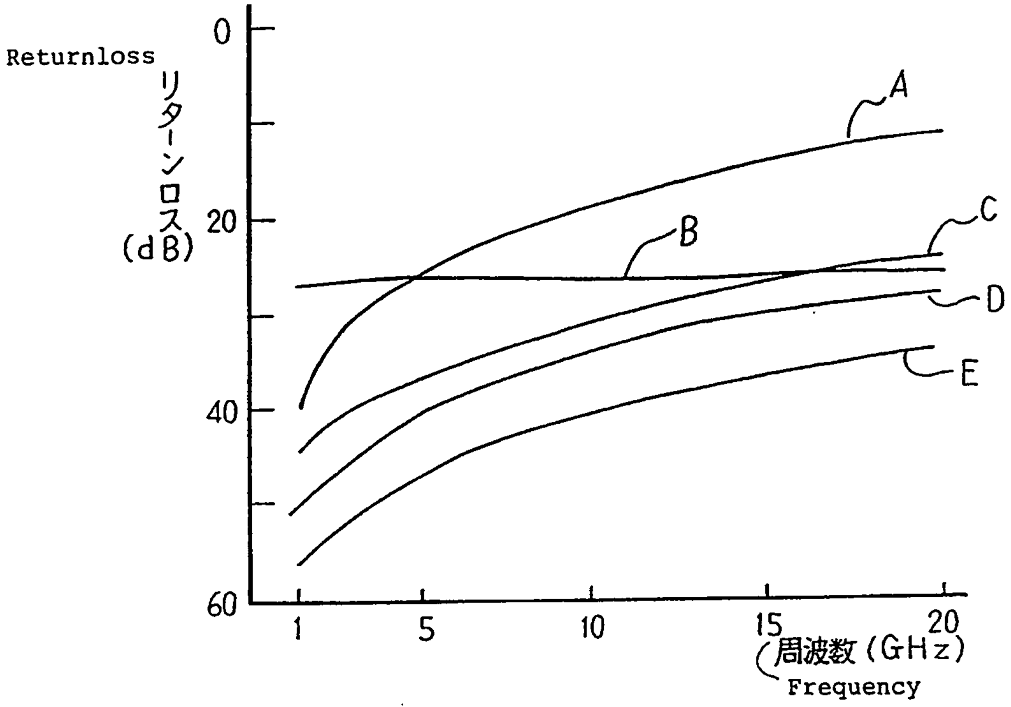

Returnloss
リターンロス (dB)
0
20
40
60
1
5
10
15
20
周波数 (GHz)
Frequency
A
B
C
D
E

FIG. 4

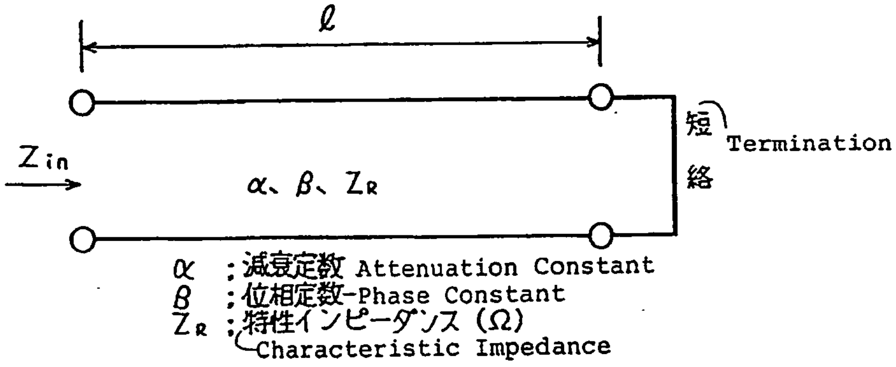

ℓ
Zin
α、β、ZR
短絡
Termination
α ;減衰定数 Attenuation Constant
β ;位相定数-Phase Constant
ZR ;特性インピーダンス (Ω)
Characteristic Impedance

FIG.5

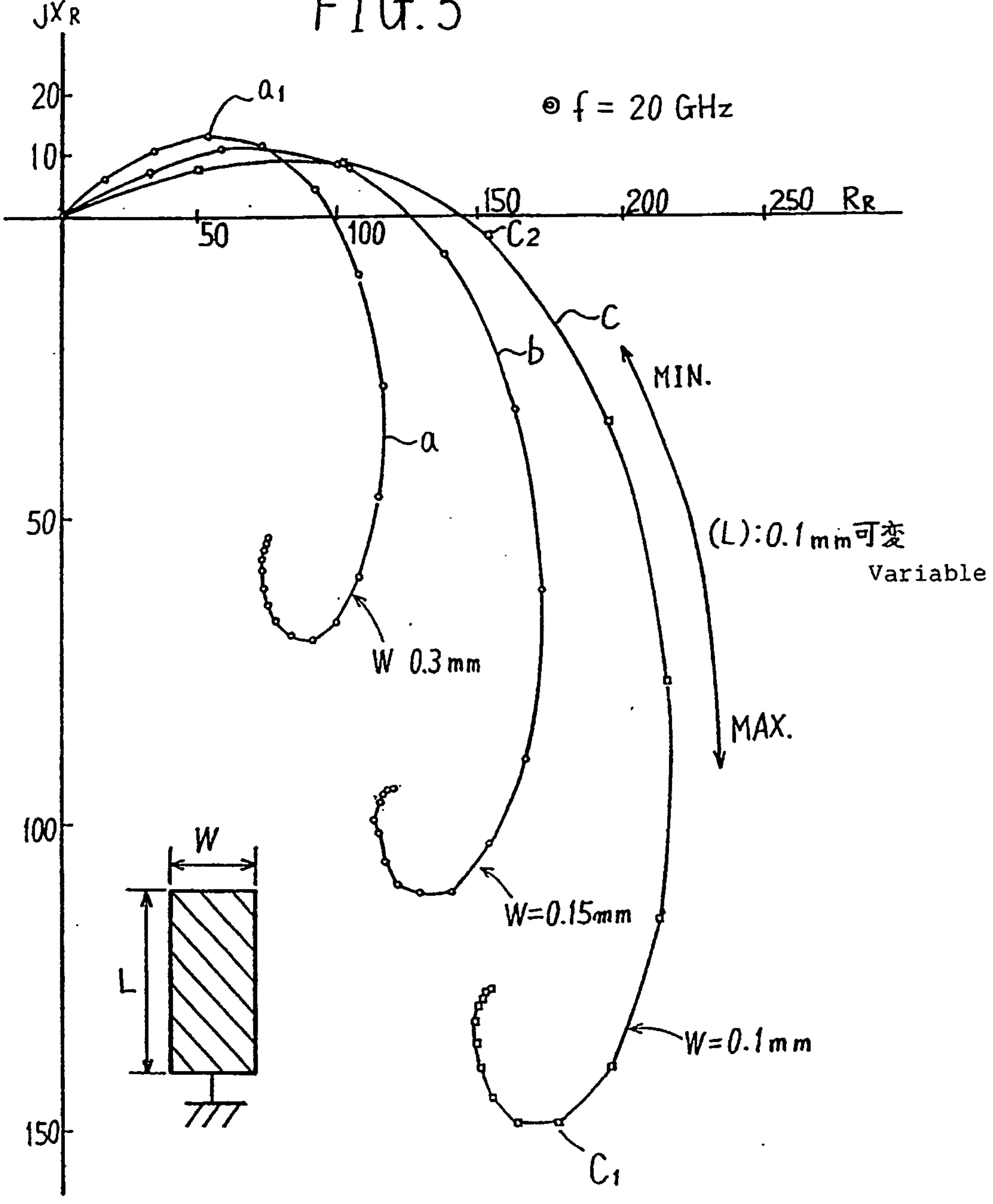

jX_R
20
10
50
100
150
a₁
⊙ f = 20 GHz
50
100
150
200
250
R_R
C₂
C
b
MIN.
a
(L):0.1 mm可変
Variable
W 0.3 mm
MAX.
W
L
W=0.15mm
W=0.1mm
C₁

FIG.6

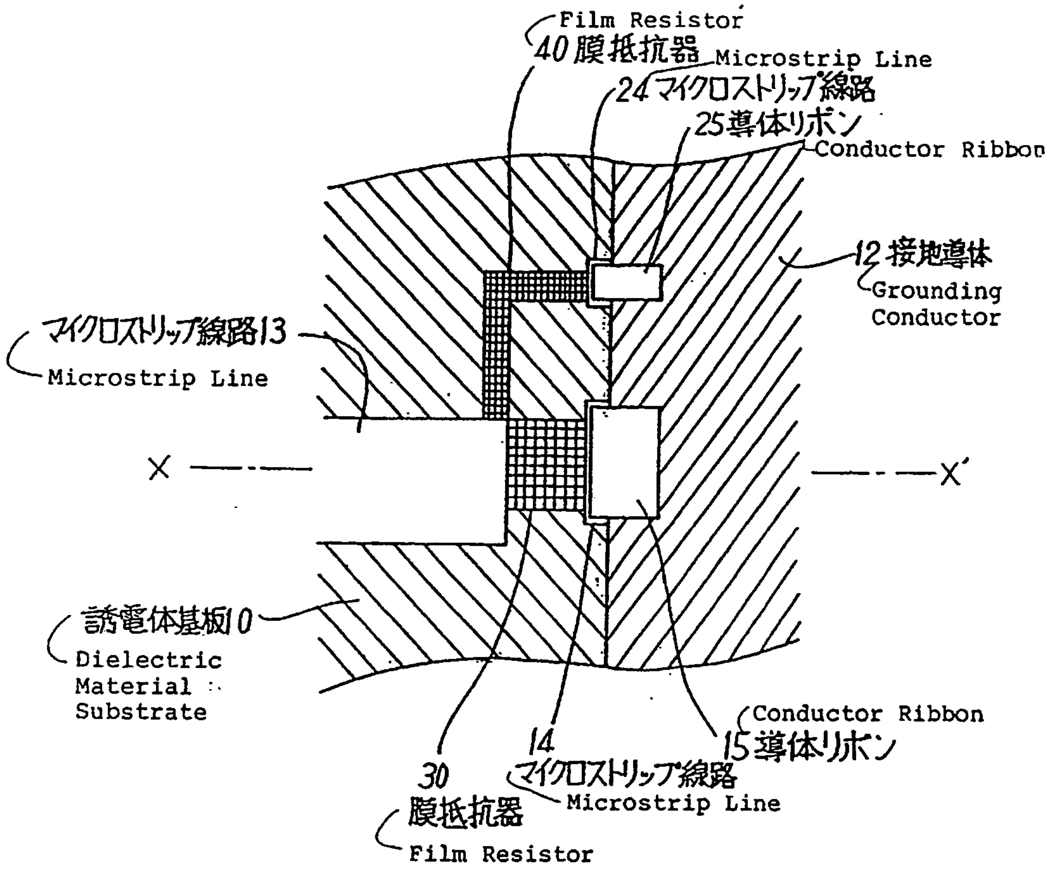

Film Resistor
40 膜抵抗器
Microstrip Line
24 マイクロストリップ線路
25 導体リボン
Conductor Ribbon
12 接地導体
Grounding Conductor
マイクロストリップ線路 13
Microstrip Line
X
X'
誘電体基板 10
Dielectric Material Substrate
Conductor Ribbon
15 導体リボン
14
マイクロストリップ線路
Microstrip Line
30
膜抵抗器
Film Resistor

FIG.7

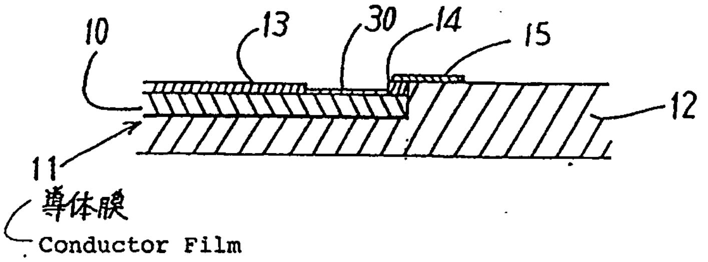

導体膜
Conductor Film

FIG. 8

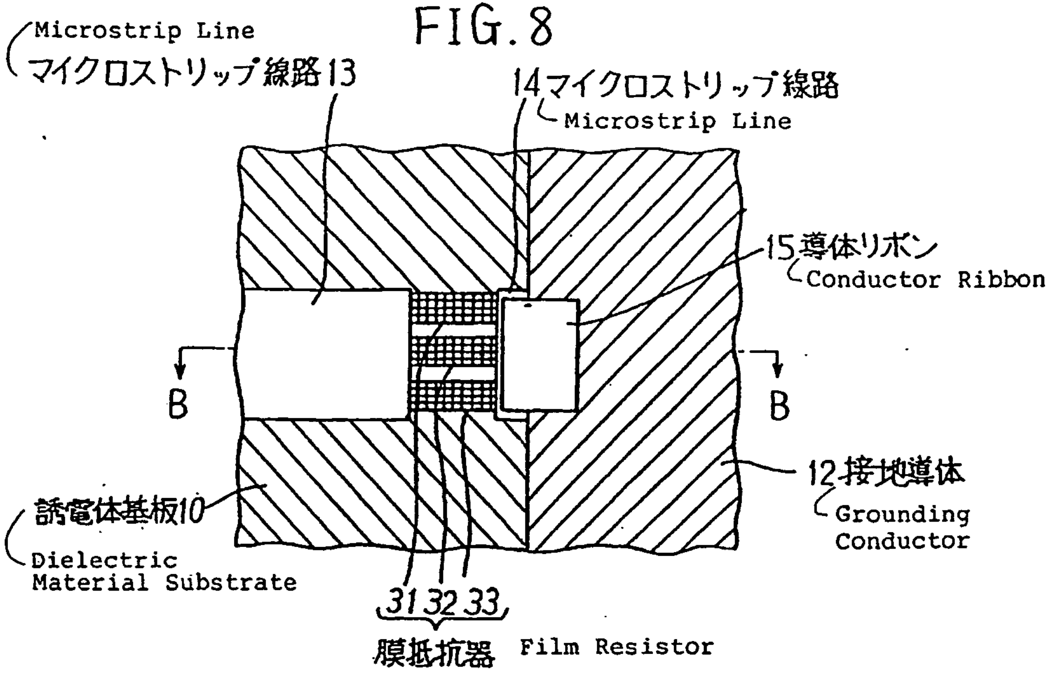

Microstrip Line
マイクロストリップ線路 13
14 マイクロストリップ線路
Microstrip Line
15 導体リボン
Conductor Ribbon
B
B
12 接地導体
Grounding Conductor
誘電体基板 10
Dielectric Material Substrate
31 32 33
膜抵抗器 Film Resistor

FIG. 9

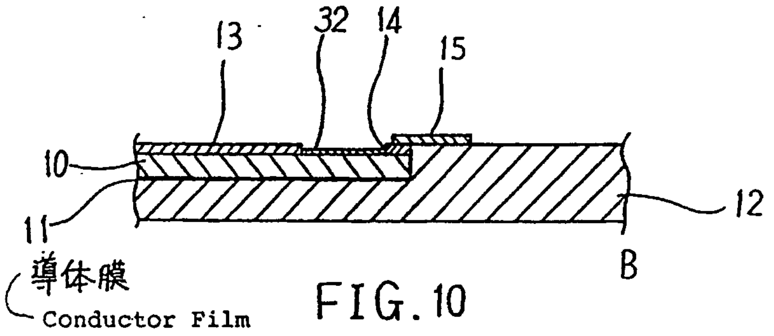
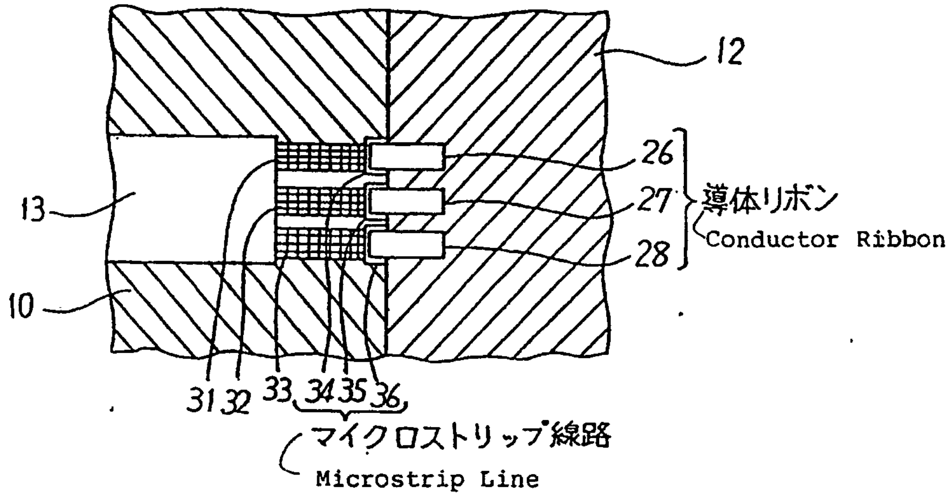

13
32
14
15
10
11
12
B
導体膜
Conductor Film

FIG. 10


12
13
10
26
27
28
導体リボン
Conductor Ribbon
31 32
33 34 35 36
マイクロストリップ線路
Microstrip Line

INTERNATIONAL SEARCH REPORT

International Application No PCT/JP90/00080

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl^5 H01P1/26

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	H01P1/26

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1926 - 1989
Kokai Jitsuyo Shinan Koho	1971 - 1989

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
Y	IEEE, Trans. Microwave Theory and Techniques, Vol. MTT-20, No. 4, April, 1972, Pages 290 - 292, D. Lacombe "A Multioctave Microstrip 50-Ω Termination"	1
Y	JP, A, 53-82147 (NEC Corporation), 7 February 1978 (07. 02. 78), Page 2, upper left column, line 6 to upper left column, line 15, page 2, upper right column, line 8 to page 2, lower left column, line 5, page 3, upper right column, 3rd line from the bottom to page 3, lower left column, line 5, page 4, lower left column, line 6 to lower left column, line 11 (Family: none)	1, 2, 3, 4
A	JP, U, 63-72903 (NEC Corporation), 16 May 1988 (16. 05. 88), (Family: none)	5, 6, 7, 8

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
April 23, 1990 (23. 04. 90)	April 23, 1990 (23. 04. 90)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	